

# Corrosion by Ammonium Chloride



Senior Analyst and Inspector Training  
Crude Units

# Corrosion by Ammonium Chloride



## Characteristics

- Can cause severe corrosion and pitting of many exchanger tube materials including carbon steels, copper alloys, and stainless steels
- Can occur wherever we use ammonia for neutralization
- Ammonium chloride ( $\text{NH}_4\text{Cl}$ ) salts cause corrosion only when they are wet
  - Dry salts don't cause corrosion, but are a foulant
- Ammonium chloride sublimates, meaning it can go directly from being a vapor to a solid salt without becoming a liquid

# Corrosion by Ammonium Chloride



## Characteristics (Cont'd)

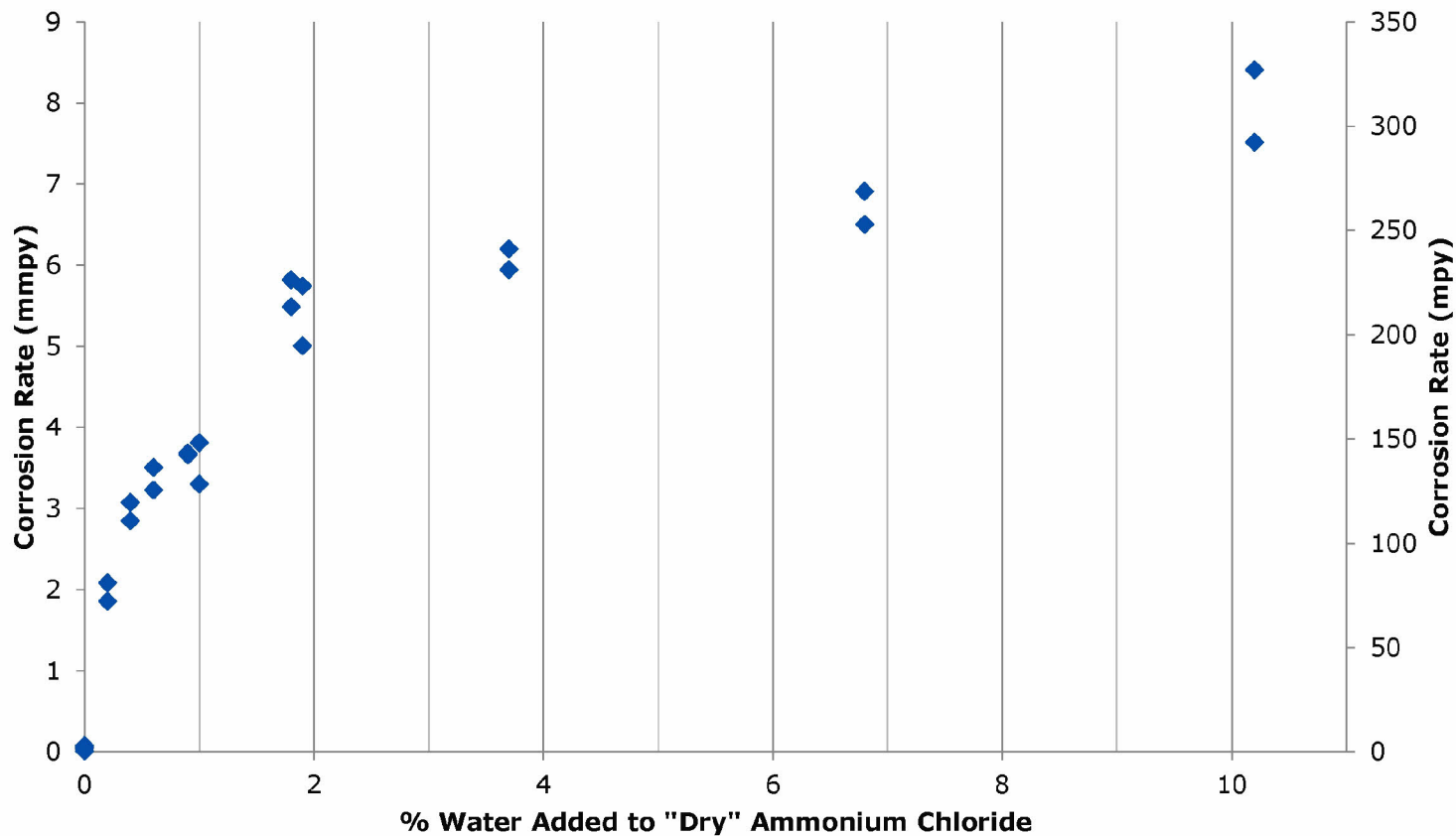
- $\text{NH}_4\text{Cl}$  can deposit and cause corrosion
  - Overhead heat exchanger tubes
  - Possibly the top of the atmospheric column
- Amine chlorides (from amine corrosion inhibitors) can also cause corrosion
  - Amine chlorides are more thermally stable than ammonium chlorides

# Effect of Water on Ammonium Chloride Corrosion Rates



- It takes very little water to cause severe [ $>50$  mpy ( $>1.3$  mmpy)] corrosion if salts are present. The Chloride BIP Nalco/Chevron research indicates less than 0.3% water is needed, and the water can be in the form of vapor, initially removed from a dry salt.
- Only a very small water vapor pressure is needed to cause problems if we have salts present

# Effect of Water on Ammonium Chloride Corrosion Rates



# Summary of Chloride Salt Corrosion



- If temperatures are above the dewpoints for ammonium chloride and water → no corrosion
- If ammonia and chloride levels are low enough that water condenses before the ammonium chloride salts → general wastage
  - Degree of corrosion depends upon the salt concentration, ratio of ammonia to chlorides, and other constituents that move the pH from alkaline (low corrosion rates) to acidic (high corrosion rates)
- If ammonia and chloride levels are high and salt condenses before the water → localized corrosion
  - Severity of the corrosion depends on velocity, whether water can reach the salts, and if sufficient wash water is injected

# Corrosion by Ammonium Chloride (Cont'd)



## Prevention

- Don't let ammonium chloride salts form and deposit
  - Inject ammonia into the overhead line just upstream of the water wash
  - Keep the top of the column hot and dry; overhead process temperature should be at least 25°F (14°C) above the calculated  $\text{NH}_4\text{Cl}$  sublimation point and water dew point temperatures
  - Inject plenty of water upstream of the overhead exchangers to dissolve the ammonium chloride; 30% of the injected water should remain unvaporized
- Use alloys – minimizes corrosion problems but not fouling:
  - Nickel-based alloys are best but expensive
  - Titanium can work well as long as the threshold pitting temperature for the specific titanium grade is not exceeded
- Ensure good desalting – 0.5 lb salt per thousand barrels oil max. (1.4 kg/m<sup>3</sup>)
- Inject caustic for further salt removal

# Corrosion by Ammonium Chloride (Cont'd)



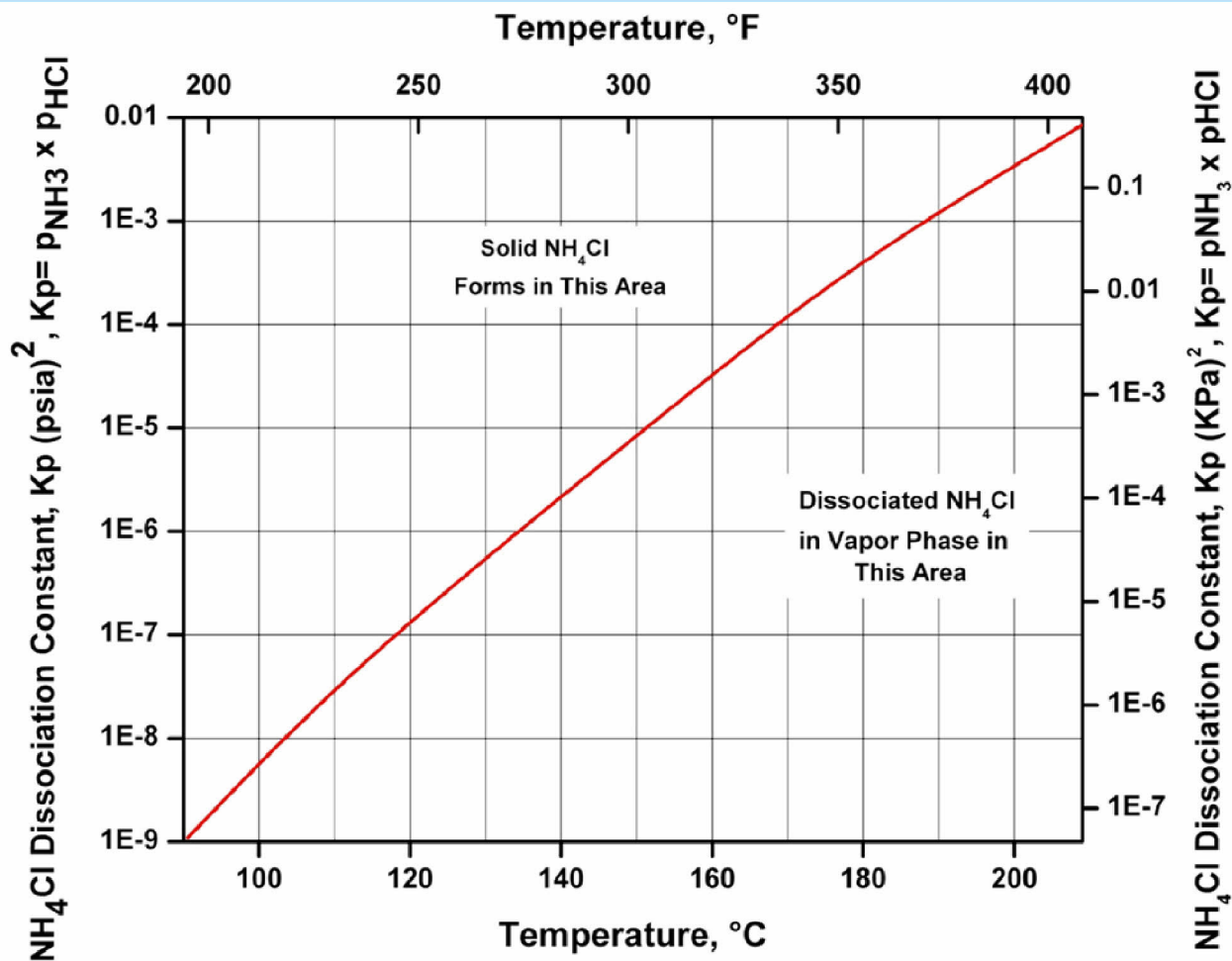
## Inspection

- See Inspection Strategy IS-6 (API 571 #8)
  - Eddy current, IRIS, and/or laser optics for exchanger tubes
  - Visual inspection at top of column

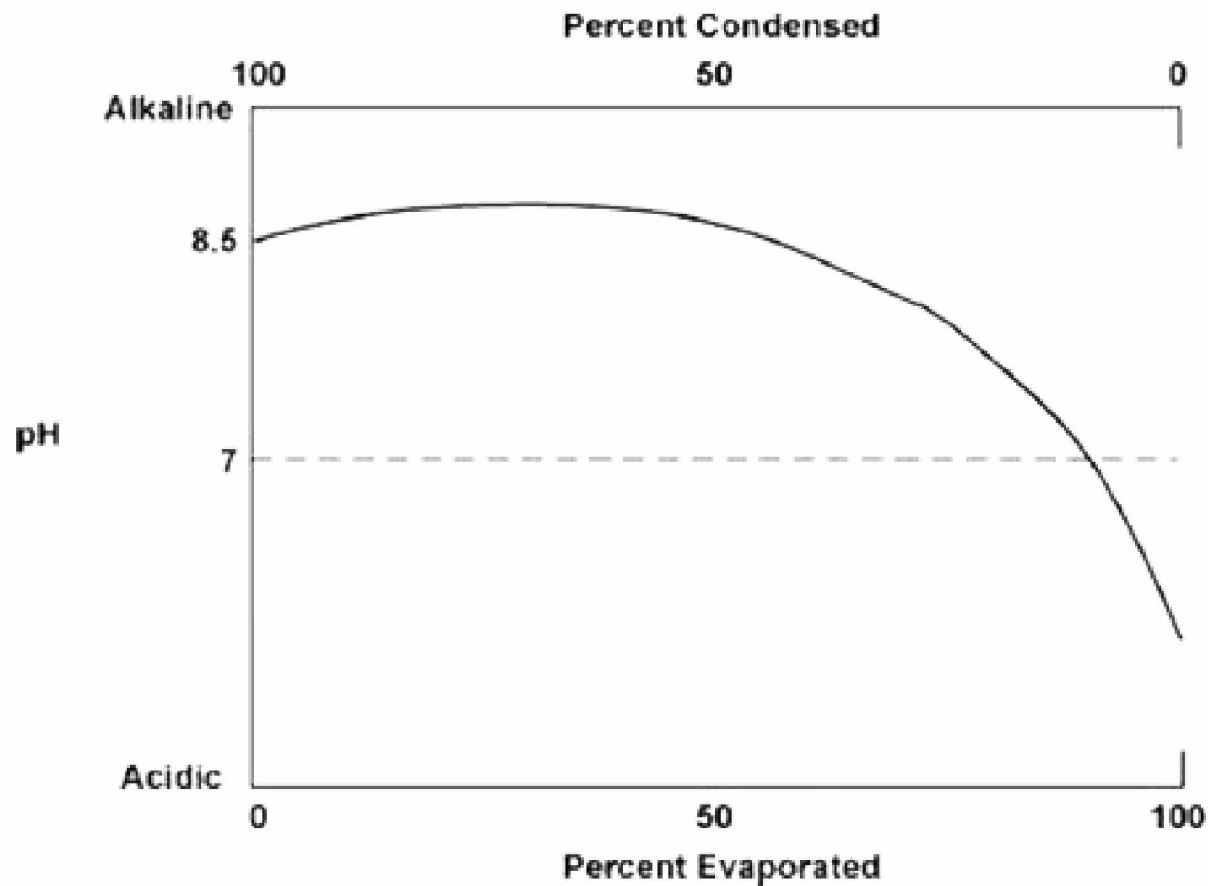


# Ammonium Chloride

## Sublimation Curve



# Change in Water pH With Evaporation/Condensation



# Titanium for Heat Exchanger Tubes



Grade	Composition	Relative Cost	Threshold Pitting/Crevice Corr. Temp., °F (°C)
2	Commercially Pure Titanium	Lowest	220 (105)
12	Ti Alloy: 0.8% Ni 0.3% Mo	20-25% Higher	350 (175)
7	Ti Alloy: 0.2% Pd	Twice Cost of Grade 2	350-450 (175-230)

# Typical Areas in Crude Units Susceptible to Ammonium Chloride Corrosion



- Atmospheric column overhead exchangers and possibly top of column
- Salts only corrosive when wet
- Keep top of column hot and dry/above ~270°F (130°C) minimum
- Ni-based alloys effective
- Ti alloys OK if don't exceed threshold pitting T

